# A Parallel Marching on in Time Solver Accelerated by the Plane Wave Time Domain Algorithm

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Time domain integral equation (TDIE) solvers, while ideal candidates for analyzing broadband/nonlinear electromagnetic phenomena, rapidly become impractical for large-scale simulations because of their high computational complexity and memory requirements. Various fast algorithms have recently been proposed to overcome the computational burden of classical marching-on-in-time (MOT) solution of TDIEs. One such algorithm, the multilevel plane wave time domain (PWTD) method dramatically accelerates the solution for analysis of arbitrarily shaped scatterers (B. Shanker et al., *IEEE Trans. Antennas Propagat.*, to appear in Jan. 2003). In a PWTD enhanced MOT solver, at each time step, the computation of the fields (due to the previously calculated currents) is performed in two stages: The “near-field” interactions are evaluated directly; the “far-field” interactions are calculated by the PWTD algorithm by expressing the fields in terms of plane waves and efficiently propagating them using diagonal translation operators. To date, the PWTD-augmented MOT solvers have been successfully applied to accelerating analysis of large-scale scattering, radiation, electromagnetic compatibility, etc. on serial computing platforms.

Here a parallel paradigm is proposed to further increase the capabilities of the PWTD-accelerated MOT solvers. The efficiency of the parallel solver is directly related to the balanced distribution of the computational load and memory requirements among multiple processors. In the proposed scheme, the near-field computations are evaluated in parallel in a straightforward manner, whereas the far-field computations are distributed using a hybrid spatial/angular partitioning scheme. At the lower levels of the PWTD algorithm, the unknowns are divided among the processors according to their spatial locations, whereas higher-level plane waves are distributed according to their angles. The proposed scheme has been implemented on a distributed memory parallel cluster using the massage passing interface (MPI) for inter-processor communication and applied to a range of transient scattering problems to verify its accuracy and efficiency. Computational complexity, parallel speed-up, and timing results of these problems will be presented at the conference. In parallel to the above effort, a parallel FFT-based algorithm, the time domain adaptive integral method (TD-AIM), has been developed (A. E. Yılmaz et al., *URSI Digest*, 319, 2002). The second goal of this study is to give a thorough comparison of the TD-AIM and the multilevel PWTD algorithms in terms of their parallelization, and their theoretical and practical limitations.